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Mission Highlights STS-87

IS-1997-11-001.087JSC
November-December 1997

Two EVAs salvage satellite and mission

Space Shuttle *Columbia* and its crew concluded a 16-day science mission on Dec. 5, 1997, which included an unplanned but dramatic retrieval of the Spartan satellite.

"It was an action-packed flight," Commander Kevin Kregel said. "We had a little more action than we anticipated, but with a lot of help from folks here on the ground we managed to take a lemon and make lemonade out of it."

"We did a great space walk," he added. "First to capture a satellite which I think is pretty spectacular. If it had been an unmanned vehicle, any kind of problem, whether technical or procedural, it would have been gone. It would have been junk. We managed to pick up the satellite and bring it back so it will fly another day."

In addition to their microgravity experiments, the STS-87 crew performed two EVAs to test tools and equipment planned for the International Space Station.

Mission Events

The six member STS-87 crew lifted off from Kennedy Space Center at 1:46 p.m. CST on November 19, 1997, to begin a 16-day flight devoted to microgravity science, satellite-based studies of the sun and a space walk to prepare for the assembly of the International Space Station.

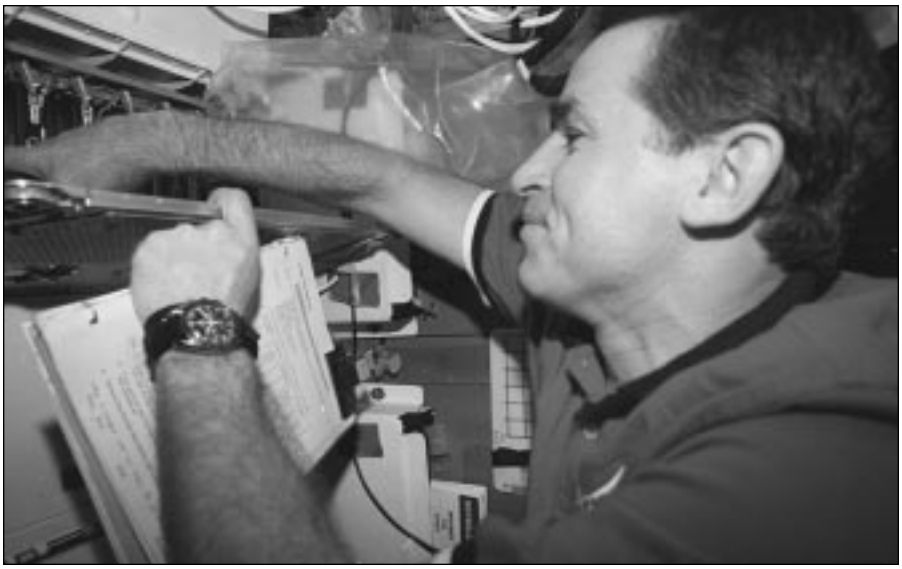
On the first full day on orbit the crew activated the United States Microgravity Payload (USMP) and

Astronauts Winston Scott (left) and Takao Doi (partially obscured in the shadows) await the right opportunity to grab onto the SPARTAN satellite.

Space Shuttle *Columbia*

Nov. 19 – Dec. 5, 1997

Commander:	Kevin Kregel
Pilot:	Steven Lindsey
Mission Specialists:	Kalpana Chawla
	Winston Scott
	Takao Doi
Payload Specialist:	Leonid Kadenyuk



Mission Commander Kevin Kregel sets up the mid-deck glove box.

began a checkout of the robot arm.

Mission Specialist Kalpana Chawla released SPARTAN from the robot arm on November 21, at 3:04 p.m. CST, but the satellite indicated problems with its attitude control system. The effort to regrapple the ailing satellite was called off for the day and Commander Kregel placed *Columbia* in a position to re-rendezvous with SPARTAN later in the mission.

Unaffected by the SPARTAN activity, the scientific data being collected by the suite of experiments comprising the USMP continued throughout the flight.

Astronauts Winston Scott and Takao Doi began their space walk at 6:02 p.m. CST, November 25. The two astronauts captured the SPARTAN satellite by hand at 8:09 p.m. CST, and carefully lowered it onto its support structure, latching it into place at 9:23 p.m. CST.

After completing the retrieval, the two astronauts turned their efforts towards setting up and testing equipment which will be used during the assembly and maintenance of the International Space Station. The 7 hour, 43 minute spacewalk ended at 1:45 a.m. CST.

A second EVA was added to the mission to conduct experiments that the first EVA had not had the opportunity to complete due to the retrieval of the SPARTAN satellite.

At 3:09 a.m. CST astronauts Scott and Doi began their second space walk of the mission. During the EVA the crew tested the Aercam Sprint, the free-flying video camera.

The four hour, fifty nine minute space walk ended at 8:09 a.m. CST.

Space Shuttle *Columbia* glided to a smooth touchdown at the Kennedy Space Center at 6:20 a.m. CST, on December 5, 1997.

CARGO BAY PAYLOADS

UNITED STATES MICROGRAVITY PAYLOAD-4 (USMP-4)

The Advanced Automated Directional Solidification Furnace (AADSF) processed two different alloys that are used to make infrared detectors and lasers. The goal was to understand how to develop better material processes, material performance and to reduce production costs. Advances in the quality of crystals for semiconductor materials may impact consumer products such as computers, calculators and high-technology applications such as infrared detectors and lasers. The principal investigators for the AADSF were NASA Langley Research Center, Hampton, VA; and NASA Marshall Space Flight Center, Huntsville, AL.

The Confined Helium Experiment (CHeX) was designed to better understand the effects of miniaturization on material properties which should lead to even smaller and even more efficient electronic devices, including computers of the future, with reduced costs for the consumer. Researchers hope to understand the size-dependent changes that take place in various material properties through ultra-precise measurements in cooled liquid helium. The principal investigator for CHeX was Stanford University, Stanford, CA.

Isothermal Dendritic Growth Experiment (IDGE) aided researchers in understanding the process of solidification and to improve metal manufacturing techniques. The experiment may improve manufacturing processes involved in the production of steel, aluminum and superalloys used in the production of automobiles and airplanes. The principal investigator for IDGE was the Rensselaer Polytechnic Institute, Troy, NY.

The Materials for the Study of Interesting Phenomena of Solidification on Earth and in Orbit (MEPHISTO) is an international cooperative program between NASA, the French Space Agency, the French Atomic Energy Commission and the University of Florida. The goal of the experiment was to understand how gravity-driven convection affects the production of metals, alloys and electronic materials. The research may improve products ranging from alloys for airplane turbine blades to everyday electronic materials. The principal investigator was the University of Florida, Gainesville, FL.

MICROGRAVITY GLOVEBOX FACILITY (MGBX) EXPERIMENTS

The Enclosed Laminar Flames (ELF) experiment examined the effect of different air flow velocities on the stability of laminar—or non-

turbulent—flames. Enclosed laminar flames are commonly found in combustion systems such as power plant and gas turbine combustors, and jet engine afterburners. Results of this investigation may help to optimize the performance of industrial combustors, including pollutant emissions and heat transfer. The principal investigator was the University of Iowa, Iowa City, IA.

The Wetting Characteristics of Immiscibles (WCI). Special metal alloys—known as immiscibles—contain components that do not mix in the liquid melt before solidification. Potential applications of these metal alloys include ball-bearing, electronic and semiconductor materials. The Wetting Characteristics of Immiscibles experiment was designed to study ways to control wetting behavior and ultimately result in improved materials processing on Earth for this potentially important class of alloys. The principal investigator for WCI was the University of Alabama at Birmingham.

The Particle Engulfment and Pushing by a Solid/Liquid Interface (PEP) allowed investigators to study the behavior and movement of particles as the sample is solidified from one end to the other in a convection-free microgravity environment. This research could lead to improved materials processing to benefit the automotive and aerospace industries. The principal investigator was the University of Alabama, Tuscaloosa.

The Space Acceleration Measurement System (SAMS) measured disturbances which occur when crew members move about the shuttle, when onboard equipment is operated, or when thrusters are fired to maneuver the shuttle to its proper position. Even slight, atmospheric drag on the shuttle can create disturbances that mimic gravity. Such minute changes in the orbital environment of the shuttle can affect sensitive experiments being conducted onboard. The project scientist for SAMS was located at NASA Lewis Research Center, Cleveland, OH.

Orbital Acceleration Research Experiment (OARE). The shuttle travels very rapidly through this tenuous, near-vacuum atmosphere. But the shuttle is slightly slowed, or decelerated, by friction with the gas molecules. Because the density of the atmosphere changes from day to night, the amount of friction varies proportionally. OARE makes extremely accurate measurements of these variations and other disturbances, using a sensor called an accelerometer, and records them for later analysis. The project scientist for OARE is Lewis Research Center, Cleveland, OH.

SPARTAN 201-04

The Spartan spacecraft was a carrier for two instruments that were designed to investigate the heating of the solar corona and the acceleration of the solar wind that originates in the corona.

Automated Rendezvous and Capture Video Guidance Sensor Flight Experiment. The cost of mission operations could be reduced significantly if rendezvous operations were automated. The Automated Rendezvous and Capture technology under development at the Marshall Space Flight Center in Huntsville, AL, requires little or no ground support. Onboard sensors, computers and navigation inputs from satellites provide the intelligence to complete docking maneuvers through automated operations.

EXTRAVEHICULAR EVALUATION ACTIVITIES

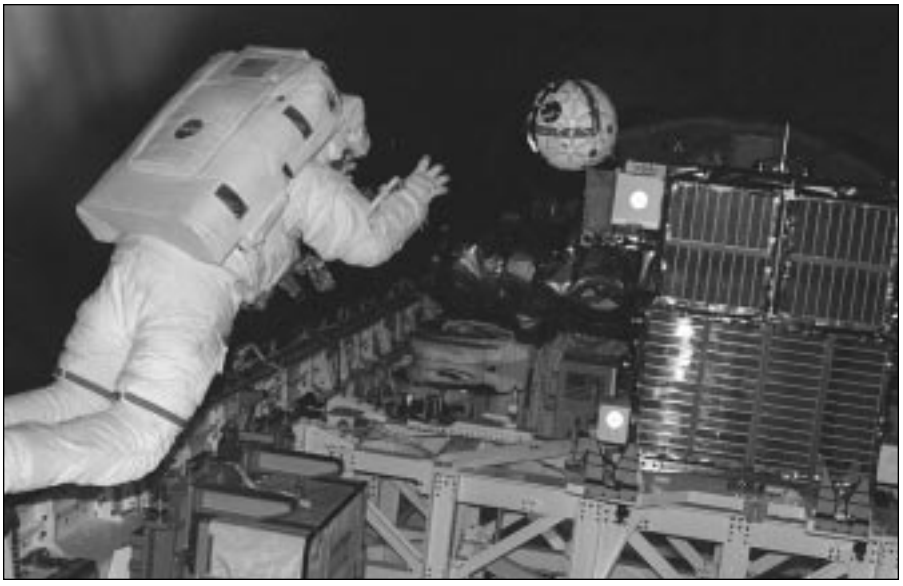
Crane: The crane is designed to aid space walkers in transporting Large Orbital Replacement Units (ORUs) with a mass as great as 600 pounds from translation carts on the exterior of the International Space Station to various work sites on the truss structure.

Battery Orbital Replacement Unit (ORU): A simulated battery for the International Space Station was used for evaluations performed during STS-87 because the batteries were among the most massive station ORUs. The ORU carrier simulates a standard International Space Station work site.

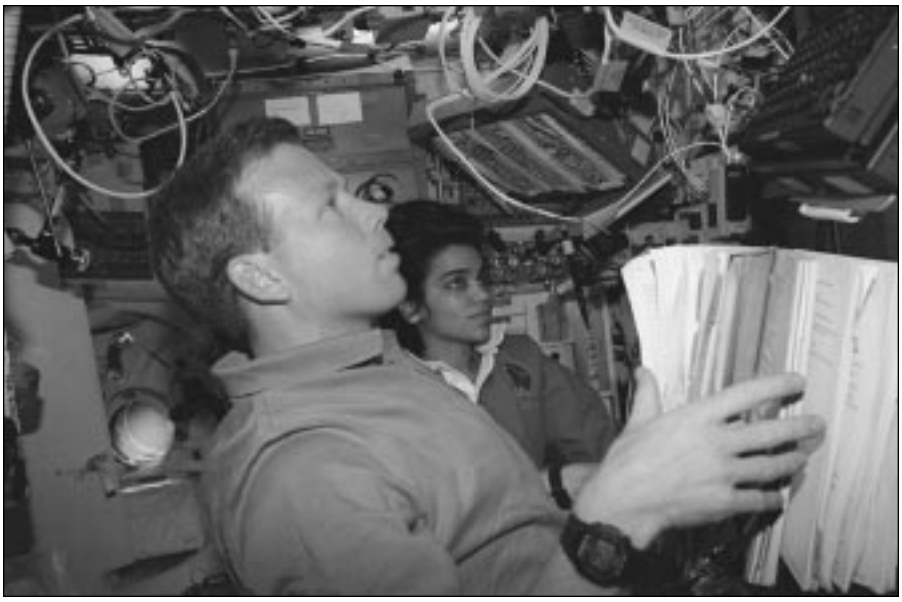
Cable Caddy: A small carrier device planned to hold about 20 feet of replacement electrical line for the space station.

Body Restraint Tether (BRT): Designed to provide a quick method of supplying stability for a space walker in a variety of locations where a foot restraint is not available.

Multi-Use Tether: A device similar to the BRT, but it has the capability to perform a greater variety of



Astronaut Winston Scott lets loose the prototype free- flying AERCam Sprint television camera.



Astronauts Steven Lindsey and Kalpana Chawla check on an experiment in the mid-deck glove box.

tasks. Different end effectors can be attached to the tether to grip station ORUs, various space walking tools or handrails.

Handling Aids: Two Scoops, handholds designed to attach to square robotics fittings on the ORU, will be evaluated for use with the simulated battery. Also, a D-handle, which looks somewhat like a small, half steering wheel, may be attached to one of the Scoops and evaluated as a tool to assist with manually maneuvering the ORU.

Restraint Aids: An ORU Tether, a flexible, spring-loaded, retracting tether that automatically can hold an ORU firmly against a steadying bracket, was attached to the crane. During the crane evaluations, the simulated battery was detached from its carrier and attached to the ORU tether to evaluate it as a temporary restraint.

The Autonomous Extravehicular Activity Robotic Camera Sprint (AERCam Sprint) was an experiment planned to demonstrate the use of a prototype free-flying television camera that could be used for remote inspections of the exterior of the International Space Station.

HITCHHIKER PAYLOADS

The Shuttle Ozone Limb Sounding Experiment (SOLSE), which demonstrated that vertical profiles of ozone can be measured with high resolution from solar ultraviolet (UV) scattering from the Earth's atmospheric limb.

The Limb Ozone Retrieval Experiment (LORE) demonstrated that vertical profiles of ozone can be measured with high resolution using sunlight scattered in the Earth's atmospheric limb.

SOLSE and LORE generated overall ozone coverage images and cross sections of the atmosphere showing ozone concentrations at different altitudes. The ability to determine where ozone depletion has occurred aids in determining man-made versus natural causes that effect the ozone layer.

LHP/NaSBE

The LHP experiment, sponsored by the Center for Space Power (Texas A & M University in Corpus Christi, TX) and managed by Dynatherm Corporation (Kelton, PA), investigated a unique thermal energy management system using a loop heat pipe. The system is comprised of a passive, two-phase flow device that transports thermal energy through semi-flexible tubes. The use of passive heat transport devices will greatly enhance thermal management on small satellites.

NaSBE, sponsored by USAF Phillips Laboratory, Albuquerque, NM, and managed by the Naval Research Laboratory, Washington, DC, studied the microgravity operation of sodium and sulfur liquid electrodes. The reaction of the battery cells in simulated geostationary and low Earth orbits was investigated.

The Turbulent Gas-Jet Diffusion Flames (TGDF) experiment studied the interaction of a steady, laminar flame with artificially-imposed flow vortices in order to understand the combustion processes of turbulent furnaces and engines to make the design of these devises more efficient for our use on Earth.

The TGDF experiment was proposed by investigators at InnoTech, Inc., and NYMA, Inc. The flight hardware was designed, built, and functionally tested by the engineers and technicians of the NASA Lewis Research Center, Cleveland, OH.

GET AWAY SPECIAL (GAS) PAYLOAD

The Cement Mixing Experiment (CME) allowed cement samples to mix with water. These samples were then used to analyze the effects of microgravity on the combination of cement and water, as well as to study the potential of using cement or similar materials in outer space.

Configuration Stability of Fluid Experiment (CSFE) was a study designed to investigate the effects of microgravity on the configuration stability of a two phase fluid system.

Computer (Compact) Disc Evaluation Experiment (CDEE) investigated the effects of the exosphere, the outer fringe region of the atmosphere of a planet, on the ability of discs to retain their information. With CD-ROM's becoming the wave of the future, experimenters want to know if they can be trusted to retain their data in space.

The Asphalt Evaluation Experiment (AEE) was an investigation that explored the effects of exposure to the exosphere on asphalt. Investigators hope the experiment will help determine better, more durable ways to make asphalt. The results of AEE will be compared with an asphalt sample not exposed to the exosphere to form a final conclusion.

CREW BIOGRAPHIES

Commander: Kevin R. Kregel (USAF). Kregel, 42, grew up in Amityville, NY, and received a bachelor of science degree in astronautical engineering from the U.S. Air Force Academy; master's degree in public administration from Troy State University.

Kregel was employed by NASA as an aerospace engineer and instructor pilot. Stationed at Ellington Field, Houston, TX, his primary responsibilities included flying as an instructor pilot in the Shuttle Training Aircraft (STA) and conducting the initial flight test of the T38 avionics upgrade aircraft.

Kregel became an astronaut in 1992, and participated in two space flights prior to STS-87.

STS-70 launched from the Kennedy Space Center, Florida, on July 13, 1995, and returned there July 22, 1995. The five-member crew aboard Space Shuttle *Discovery* performed a variety of experiments in addition to deploying the sixth and final NASA Tracking and Data Relay Satellite. During this 8 day 22 hour mission, the crew completed 142 orbits of the Earth, traveling 3.7 million miles. STS-70 was the first mission controlled from the new combined control center.

STS-78 launched June 20, 1996, and landed July 7, 1996, becoming the longest shuttle mission to date. The Life and Microgravity Spacelab mission served as a model for future studies onboard the International Space Station. The mission included studies sponsored by ten nations, five space agencies, and the crew included a Frenchman, a Canadian, a Spaniard and an Italian.

With the completion of STS-87 Kregel has more than 994 hours in space.

Pilot: Steven W. Lindsey (Major, USAF). Lindsey, 37, was born in Arcadia, CA, and received a bachelor of science degree in engineering sciences from the U.S. Air Force Academy, and a master of science degree in aeronautical engineering from the Air Force Institute of Technology.

Lindsey became an astronaut in 1996, was initially assigned to flight software verification in the Shuttle Avionics Integration Laboratory (SAIL), Lindsey also served as the Astronaut Office representative working on the Multifunction Electronic Display System (MEDS) program, a glass cockpit Space Shuttle upgrade program, and other advanced upgrade projects.

With the completion of STS-87 Lindsey has logged more than 376 hours of space flight.

Mission Specialist: Kalpana Chawla (Ph.D.). Chawla was born in Karnal, India, and received a bachelor of science degree in aeronautical engineering from Punjab Engineering College, India, a master of science degree in aerospace engineering from University of Texas, and a doctorate of philosophy in aerospace engineering from University of Colorado.

Chawla was hired by MCAT Institute, San Jose, CA, as a Research Scientist to support research in the area of powered lift at NASA Ames Research Center, California, in 1988. She was responsible for simulation and analysis of flow physics pertaining to the operation of powered lift aircraft such as the Harrier in ground effect. In 1993, Dr. Chawla joined Overset Methods Inc., Los Altos, CA, as Vice President and Research Scientist to form a team with other researchers specializing in simulation of moving multiple body problems. She was responsible for development and implementation of efficient techniques to perform aerodynamic optimization.

Chawla became an astronaut in 1995, and was assigned to work technical issues for the Astronaut Office EVA/Robotics and Computer Branches.

With the completion of STS-87 Chawla has logged more than 376 hours of space flight.

In-Flight portrait: Front, left to right, Steven Lindsey, Takao Doi and Winston Scott. Back, left to right, Kevin Kregel, Kalpana Chawla and Leonid Kadenyuk.

STS-87
Quick Look

Launch Date:	Nov. 19, 1997
Time:	1:46 p.m. CST
Site:	KSC Pad 39B
Orbiter:	*Columbia* OV-102—24th flight
Orbit/In.:	150 naut. miles 28.5 degrees
Mission Duration:	15 days, 16 hrs, 34 mns.
Landing Date:	Dec. 5, 1997
Time:	6:20 a.m. CST
Site:	Kennedy Space Center
Crew:	Kevin Kregel (CDR)
	Steven Lindsey (PLT)
	Kalpana Chawla (MS1)
	Winston Scott (MS2)
	Takao Doi (MS3)
	Leonid Kadenyuk (PS1)
Cargo Bay Payloads:	Spartan 201-04, USMP-4, EDFT equipment, SOLSE, NaSBE, OARE, LHP, TGDF, GAS-036
In-Cabin Payloads:	Sprint/AERCAM

Mission Specialist: Winston E. Scott (Captain, USN). Scott, 47, was born in Miami, FL, and received a bachelor of arts degree in music from Florida State University and a master of science degree in aeronautical engineering from the U.S. Naval Postgraduate School.

Scott became an astronaut in 1992, and served as a mission specialist on STS-72. During the 9-day flight the crew aboard Endeavour retrieved the Space Flyer Unit (launched from Japan 10-months earlier), deployed and retrieved the OAST-Flyer, and conducted two space walks to demonstrate and evaluate techniques to be used in the assembly of the International Space Station.

With the completion of STS-87 Scott has logged more than 590 hours of space flight including 19 hours and 34 minutes of EVA.

Mission Specialist: Takao Doi (Ph.D.). Doi, 43, was born in Minamitama, Tokyo, Japan. He received a bachelor of engineering degree from University of Tokyo, a master of engineering degree from University of Tokyo and a doctorate in aerospace engineering from University of Tokyo.

Takao Doi studied space propulsion systems as a research student in the Institute of Space and Astronautical Science in Japan, and worked for NASA Lewis Research Center as a National Research Council research associate. He joined the National Space Development Agency (NASDA) of Japan in 1985 and has been working in the Japanese manned space program since then. He conducted research on microgravity fluid dynamics at the University of Colorado, and at the National Aerospace Laboratory in Japan as a visiting scientist.

Doi was selected by NASDA in 1985. He participated in payload specialist training from 1990 to 1992, in preparation for the Spacelab Japan mission. He reported to the Johnson Space Center in March 1995.

With the completion of STS-87 Doi has logged more than 376 hours of space flight including 12 hours and 44 minutes of EVA.

Payload Specialist: Leonid K. Kadenyuk. Kadenyuk, 46, was born in the Chernivtsi region of Ukraine. He graduated from the Chernihiv Higher Aviation School in Chernihiv, Ukraine, the GNIKI VVS USSR (State Scientific Research Institute of the Russian Air Forces Center for test pilot training), the Yuri Gagarin Cosmonaut Training Center and earned a master of science in mechanical engineering from the Moscow Aviation Institute, Department of Aircraft Construction, Moscow, Russia.

The STS-87 patch is shaped like a space helmet symbolizing the extravehicular activity on the mission in support of testing of tools for the assembly of the International Space Station. Planet Earth is shown reflected on the backside of the helmet. The Space Shuttle *Columbia* forms the interface between the Earth and the heavens, the back and the front sides of the helmet in profile. The three red lines emerging from *Columbia* represent the astronaut symbol as well as the robot arm which was used to deploy and retrieve the Spartan satellite. The letters "μg" represent the payloads studying microgravity science in space on this USMP-04 mission. Gold flames outlining the helmet visor represent the corona of the sun, which was studied by Spartan. The flag of Ukraine is next to the name of the payload specialist who was the first person from that country to fly on the space shuttle.

Colonel Kadenyuk has been a member of the USSR Cosmonaut Team since 1976. He underwent complete engineering and flight training for Soyuz, Soyuz-TM, orbital station Salyut, orbital complex Mir, including special training as a commander of Buran reentry space vehicle.

He is one of the first NSAU Astronaut group selected in 1996 by the National Space Agency of Ukraine.